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EXPLAINING MOVEMENTS IN COMPLETED FERTILITY ACROSS COHORTS

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Abstract

A life cycle model of fertility based on the quantity-quality model of fertility successfully explains changes in completed fertility in a period in which completed fertility first fell and then rose. This model furthermore accurately predicts the timing and level of the subsequent peak in completed fertility. Regressions based on Easterlin's relative economic status theory of fertility are less successful in predicting fertility over a fifteen year period than regressions based on the quantity-quality model. Upon investigation, much of the increase in completed fertility associated with the baby boom appears to be primarily attributable to sporadic wage growth.

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INTRODUCTION*

Economists have just begun to develop models which explain cross sectional differences in both the total number of children ever born to a woman over her lifetime (which I shall define to be completed fertility) and the "quality" of each child. The cross-sectional results derived from the testing of these "quantity-quality" models have been used to explain the fall over time from high fertility levels to low fertility levels; this decrease in fertility has then been attributed to increases in the educational attainment of the population and in the value of the mother's time. There has been some concern that the cross sectional quantity-quality models would not be able to explain the large increase in completed fertility associated with the "baby boom". This paper will demonstrate that such a fear is unfounded. These models, with some further development, explain temporal movements in completed fertility in the United States quite well.

Perhaps the strongest test of a model's worth in a time series context is how accurately the model is able to predict a peak or trough. Regressions based on the cross sectional quantity-quality models of fertility and estimated over a period in which fertility first fell and then rose correctly predict the timing and level of the subsequent peak in completed fertility and in general successfully predict fertility over a fifteen year period. The principal alternative explanation of the baby boom is Easterlin's relative economic status theory. Regressions which attempt to test Easterlin's theory predict that completed fertility will peak at least five years before it actually peaks and systematically predict fertility to be below its actual level. Trial by predictive power therefore suggests that the quantity-quality models

1) do explain temporal movements in completed fertility and 2) offer a more appropriate theory of fertility than Easterlin's relative economic status model.

THEORETICAL STRUCTURE

Willis (1973), DeTray (1973), and Becker and Lewis (1973) have developed important static economic models explaining completed fertility. Households are postulated to have a well defined utility function with the number of children, the "quality" of each child, and other goods as elements. Utility is maximized against the household's time and income budget constraints and against the household's production capabilities. The number of children demanded then is a function of non-wage earnings, the husband's wage rate, the wife's wage rate, the husband's efficiency in producing items entering the preference function, the wife's efficiency in producing items entering the utility function, and the price of market goods.

This model will now be extended to allow maximization of utility in a life cycle context. Households are postulated to have the following utility function:

$$u(S_1, S_2, \dots, S_t, Q_1, Q_2, \dots, Q_t, N_1, N_2 \dots, N_t), \tag{1}$$

where S_i = non-child consumption level in period i,

Q_i = "quality" of each child in period i,

N_i = number of children in period i.

Market goods and household time are used to produce the commodities which enter the utility function in equation (1). In each period for each household member, the sum of the time spent working and in household production must be equal to the total time available. Furthermore, the present value of the household's expenditures on market goods must be less than or equal to the present value of the household's income over the life cycle. The household maximizes the utility function described in (1) subject to its production possibilities and to the various time and goods budget constraints. Ignoring losses associated infant mortality, completed fertility equals N, where $N = N_j = N_{j+1}$ for all $j \geq j^*$. The total number of children demanded (N) will be a function of the husband's efficiency in producing various items entering the utility function (α), the wife's efficiency in producing various items entering the utility function (β), non-wage income (v), the husband's real wage in period 1 (w_{h1}) the husband's real wage in period 2 (w_{h2}), ... , the husband's real wage in period t (w_{ht}), the wife's real wage in period 1 (w_{w1}), the wife's real wage in period 2 (w_{w2}), ... , the wife's real wage in period t (w_{wt}), the real interest rate in period 1 (r_1), the real interest rate in period 2 (r_2), ... , the real interest rate in period t (r_t), a vector of prices of market goods in period 1 ($\langle p_1 \rangle$), a vector of prices of market goods in period 2 ($\langle p_2 \rangle$), ... , a vector of prices of market goods in period t ($\langle p_t \rangle$).

$$N = f(\alpha, \beta, v, w_{h1}, w_{h2}, \ldots, w_{ht}, w_{w1}, w_{w2}, \ldots, w_{wt}, r_1, r_2, \ldots, r_t, \langle p_1 \rangle, \langle p_2 \rangle, \ldots, \langle p_t \rangle) . \quad (2)$$

Note that I have not explicitly derived a demand function for the number of children (N). I have used the household production framework in a life cycle context to generate some insight into which variables should enter a demand function for number of children. The life cycle context of this model implies that cohorts at different points in their life cycle will be affected differently by and will therefore react differently to the same cyclical change (e.g., $\frac{dN}{dw_{hi}} \neq \frac{dN}{dw_{hj}}$, $i \neq j$). Another prediction of this life cycle model is that a cyclical change will have an impact on the completed fertility of many cohorts; thus, long and short lags are introduced into the relationship between the business cycle and the number of children ever born.

A demand function for births in life cycle period j ($\Delta N_j = N_{j+1} - N_j$) could be similarly "derived." However, the static cross sectional models of fertility developed by Willis (1973), DeTray (1973), and Becker and Lewis (1973) are models of completed fertility and are most directly tested in a time series context when measures of completed fertility are used. Changes in a birth rate measure such as ΔN_j reflect changes in the timing of births as well as changes in completed fertility. It is therefore impossible to ascertain the impact of cyclical changes on completed family size from a knowledge of the effect of cyclical changes on birth rates without additional information. Thus, one of the contributions of this time series study is the explanation of differences in completed fertility rather than of differences in birth rates.

Virtually every other study of time series fertility has attempted to explain changes in birth rates. Becker (1960), Kirk (1960), and Silver (1965) found that birth rates move procyclically. In contrast to the above studies, which related birth rates to current income, Easterlin (1966, 1968, 1969, 1973) argued that birth rates are also affected by parental consumption. "It seems plausible to argue that the consumption levels experienced in the parents' household served, among other things, to shape their current preferences [for material goods]." (Easterlin 1966, p. 140). *Ceteris paribus*, an increase in parents' consumption levels increases their children's relative preference for material goods, leading to a reduction in the number of children demanded. This theory, considered by some to be ad hoc, would certainly be more acceptable if it were part of a more general and empirically verified theory of taste formation. In his 1973 article, Easterlin presented some imagininative graphical analysis supporting his theory in which he showed that birth rates indeed increase when current income relative to parental income increases. Wachter (1975) and Lee (1977) have also found that "relative income" had a positive impact on birth rates, while Butz and Ward (1977) did not find relative income measures to affect birth rates consistently.

EMPIRICAL IMPLEMENTATION

Let us now turn to the data. The cumulative birth rate of U. S. women 47 years old as of January 1 in year t (N47) is used to measure completed fertility. Between 1923 and 1956, N47 fell from 3.737 to 2.229. The baby boom was associated with a large (more than one child) increase in completed fertility. By 1974, N47 had risen to 3.016, and in 1981, N47 is expected to peak in the vicinity of 3.4 children.[1]

Several variables measure labor market opportunities (W_{hj}, W_{wj}) as they vary over the life cycle. Separate time series on wages for men and women and which span a significant period of time do not appear to exist. There does exist, however, a time series on manufacturing wages. An increase in manufacturing wages will be associated with increases in both the husband's wage and the wife's wage.[2] Numerous income and substitution effects accompany these increases and the net impact is unclear a priori. Cross sectional evidence suggests that an increase in the female wage has a strong negative impact on fertility, but the evidence on the effect of an increase in the male wage is ambiguous.

The effect of an increase in wages will vary systematically over the life cycle. If capital markets have some imperfection, then younger families, with fewer assets, will face a higher cost of borrowing money. Thus, for younger households, there will be a larger income effect accompanying a change in wages. If the observed income elasticity of demand for numbers of children is postive, then the elasticity of numbers of children with respect to early life cycle wages should be more positive than the elasticity of numbers of children with respect to late life cycle wages. This is reinforced by life cycle variation in substitution effects. An unexpected increase in wages increases the relative price of having young children and leads to substitution toward less time intensive activities in the "current" period and toward consumption and childbearing in later periods. The ability to postpone childbearing mitigates the increase in the cost of having children associated with an increase in wages. As women approach menopause, it becomes increasingly costly to postpone bearing children, and consequently an increase in wages entails a greater increase in the relative price of children.

Because of the limited number of observations in this time series data, I have chosen to summarize the opportunities that cohorts face over their adult life cycle in the following five-year age groupings: 20-24, 25-29, 30-34, 35-39, 40-44. Define WM to be the natural logarithm of the total compensation per hour at work in 1957 dollars for production workers in manufacturing. Now define WM21 to be the average of the value of WM lagged 25 (= 47-22) years and of the value of WM lagged 23 (= 47-24) years. Thus

WM21 is an average of the (log) manufacturing wages in the economy when members of a cohort were 22 and 24 years old. WM22 is defined to be the average of WM lagged 20 (= 47-27) years and of WM lagged 18 (= 47-29) years. WM31 is defined to be the average of WM lagged 15 (= 47-32) years and of WM lagged 13 (= 47-34) years. WM32 is defined to be the average of WM lagged 10 years and of WM lagged 8 years and WM41 is defined to be the average of WM lagged 5 years and of WM lagged 3 years. Accordingly, WM22, WM31, WM32, WM41 measure the manufacturing wages that occured when members of a cohort were in their late twenties, early thirties, late thirties, and early forties respectively.

An increase in the unemployment rate is hypothesized to be associated with an increase in uncertainty.[3] As uncertainty rises, the risk of default increases, causing lenders to increase the cost of borrowing. Moreover, in periods of great uncertainty, households increase their demand for liquid funds and correspondingly reduce their demand for capital expenditure (such as bearing children). Therefore, since childbearing is more expensive in periods of high unemployment, an increase in the unemployment rate is predicted to lead to a decrease in completed fertility. Using the same lag structure that was used to formulate the manufacturing wage variables, UA21, UA22, UA31, UA32, and UA41 have been formed from a Lebergott-BLS unemployment series that incorporates Darby's (1976) revised unemployment data for the 1930's.

An increase in parental education is hypothesized to increase productivity in producing child quality more than productivity in producing numbers of children; more educated parents are more efficient in passing on knowledge and are perhaps more efficient in contraception. The resultant substitution away from numbers of children (and toward child quality) is expected to be strong enough to overcome the weak positive income effect associated with the increase in household productivity. Knowledge may be increased by increasing the number of years spent in school or by increasing the intensity of learning in each year. The mean years of schooling completed by persons 30-34 years old, lagged 15 years, (E) measures the educational attainment of persons currently 47 years old. Define TP to be the number of teachers and other instructional staff in public elementary and secondary day schools per child aged 5-17. An increase in TP may reflect either an increase in the fraction of school age children who attend school or an increase in the quantity of teacher inputs per child in school. Kenny (1977) found a significant negative relationship between class size and cognitive achievement, ceteris paribus. Therefore TP appears to be an appropriate measure of the intensity of learning as well as of educational attainment. Now define TPGS to be the average of TP lagged 41 (= 47-6) years and of TP lagged 39 (= 47-8) years. Thus, TPGS measures the number of teachers per child of school age when members of a cohort were in grade school. TPMS and TPHS similarly measure the number of teachers per child when members of a cohort were in "middle" school and in high school, respectively. Define TPMS to be the average of TP lagged 37 (= 47-10) years and of TP lagged 35 (= 47-12) years, and define TPHS to be the average of TP lagged 33 (= 47-14) years and of TP lagged 31 (= 47-16) years.

Two sets of variables have been constructed to test Easterlin's relative economic status hypothesis. As noted above, he postulates that tastes are in part determined by the consumption levels experienced in the parents' household. Accordingly, let CNSM equal the natural logarithm of per capital real personal consumption expenditures. The variables CNSMGS, CNSMMS, and CNSMHS have been created with lags identical to the lags of the teachers per child variables. Furthermore, since Easterlin (1973) has also used lagged unemployment rates to measure relative economic status, UAGS, UAMS, and UAHS have been generated from the UA series with the same lags as the teachers per child variables.

I have been unable to find adequate time series measuring either non-wage income (v) or real interest rates (r_i). It is extremely difficult to obtain a good measure of non-wage income even from recent data. The real interest rate, which equals the nominal interest rate less the expected rate of inflation, is never measured with certainty; moreover, those series on real interest rates which have been generated for the post-war era have "found" there to be very little fluctuation in the real rate of interest. No variables measuring the relative price of certain purchased goods ($<p_i>$) are used in the regressions reported below.

EMPIRICAL RESULTS

Ordinary least squares regressions explaining variation in completed fertility (N47) between 1923 and 1974 are reported in Table 1. The educational attainment and teachers per child variables are entered in regressions (1) and (2), respectively. Mean educational attainment (E) is essentially a linear function of time. There is, however, much more cyclical variation in the number of teachers per child of school age (TP). It is thus not surprising to find that there is no positive autocorrelation in regression (2) and that no conclusion about the existence of positive autocorrelation can be drawn in regression (1). The regressions fix the decline and subsequent increase in completed fertility quite well; nearly 98 percent of the variance is explained. The standard error of the estimate is approximately .08 children.

TABLE 1

REGRESSIONS

(Standard Errors in Parentheses)

Ind. Vars. \ Childhood Ind. Vars.	(1) E	(2) TP_	(3) CNSM_	(4) UA_
CONSTANT	-3.619	6.197[a]	20.696[a]	3.607[a]
	(2.397)	(1.754)	(3.430)	(.249
WM21	.892	3.015[a]	1.981[a]	.579
	(.797)	(.711)	(.582)	(.580)
WM22	1.313[a]	2.666[a]	2.062[a]	.963
	(.516)	(.560)	(.441)	(.486)
WM31	.596	-.116	.386	1.456[a]
	(.371)	(.492)	(.419)	(.623)
WM32	-3.056[a]	-3.898[a]	-2.395[a]	-1.115
	(.514)	(.567)	(.522)	(.675)
WM41	-2.774[a]	-1.635[a]	-.823	-2.223[a]
	(.436)	(.595)	(.562)	(.535)
UA21	-.018[a]	-.014	-.014[a]	-.014[a]
	(.007)	(.009)	(.007)	(.006)
UA22	.006	.017	.008	-.007
	(.008)	(.009)	(.007)	(.008)
UA31	.024[a]	.019[a]	.021[a]	.014[a]
	(.006)	(.008)	(.006)	(.006)
UA32	.004	-.026[a]	.001	.017[a]
	(.007)	(.011)	(.007)	(.007)
UA41	-.015[a]	-.033[a]	-.006	-.003
	(.005)	(.007)	(.006)	(.005)
_GS	}	69.989	-1.012[a]	.013[a]
		(44.064)	(.337)	(.005)
_MS	.939[a]	-163.882[a]	-1.116[a]	.014[a]
	(.254)	(54.281)	(.276)	(.005)
_HS	}	52.645	-.614[a]	.003
		(48.380)	(.271)	(.005)
R^2	.976	.975	.980	.983
Durbin Watson	1.759	2.395[b]	2.345[b]	2.051
No. Obs's.	52	52	52	44
S.E.E.	.078	.081	.072	.054
Sample Period	1923-74	1923-74	1923-74	1931-74

[a]Significant at .05 level

[b]No positive autocorrelation (Durbin Watson statistic > d_u (5% level))

Manufacturing wages have a significant impact on fertility.[4] With few exceptions, the wage coefficients fall over the life cycle, as predicted. For example, an increase in wages experienced when women were in their late 20's (WM22) significantly increases fertility, while an increase in wages experienced when women were in their late 30's (WM32) significantly decreases fertility. The exceptions to the monotonic fall in the wage coefficients occur at the beginning and end of the life cycle; the significantly negative coefficients of WM41 are less negative than the coefficients of WM32, and in regression (1), the positive coefficient of WM22 is greater than the positive coefficient of WM21. The five wage coefficients sum to -3.029 and .032 in regressions (1) and (2), respectively. These figures imply that if wages were to increase from $1.00 over the entire life cycle to approximately $2.70 over the entire life cycle, then the number of children born to women aged 47 would either decrease by 3.029 or increase by .032. The three child decrease implied by the educational attainment regression is improbably large. The small increase associated with the teachers per child regression seems reasonable.

The prediction that an increase in unemployment is associated with a decrease in completed fertility receives little support. Unemployment lagged to occur when women were in their early forties (UA41) is significantly negative; UA21 and UA32 are each significantly negative in only one of the first two regressions. However, unemployment lagged to occur when women were in their early thirties (UA31) is significantly positive. In regression (2), the summed unemployment coefficients imply that if the unemployment rate were to increase from 6 percent over the entire life cycle to 7 percent over the entire life cycle, then completed fertility would fall by .037.

In regression (1), a similar increase in the unemployment rate leads to a .001 increase in N47.[5]

An increase in education is predicted to be associated with a biased increase in household productivity which leads to a decrease in the cumulative birth rate. The incorrect and significant positive sign of mean years of completed schooling (E) in regression (1) probably reflects the fact that there is very little cyclical variation in E and that E is thus almost a trend variable. In regression (2) an increase in the number of teachers per child of school age when women were in "middle" school (TPMS) significantly decreases fertility. The TPGS, TPMS, and TPHS coefficients sum to -41.248. Thus, the approximately .02 increase in TP between 1900 and 1970 is estimated to lead to a .8 fall in completed fertility.

In regressions (3) and (4), variables testing Easterlin's relative economic status hypothesis replace the education variables found in regressions (1) and (2). The "Easterlin" regressions have slightly greater explanatory power than the quantity-quality regressions just discussed. The hypothesis that there is positive autocorrelation is rejected in the per capita consumption expenditures regression (regression (3)) but not in the unemployment regression (regression (4)).

The wage and unemployment coefficients in regression (3) are similar in sign and significance to the wage and unemployment coefficients of regression (1). The sum of the wage coefficients in the consumption expenditure regression (1.211) suggests that an increase in wages leads to a large increase in completed fertility. This implausible prediction casts considerable doubt on the usefulness of this regression. The significant negative coefficients of CNSMGS, CNSMMS, and CNSMHS are consistent with Easterlin's hypothesis that, holding adult income constant, an increase in the consumption levels experienced in the parents' household increases relative preferences for material goods. However, completed fertility is too responsive to childhood consumption measures, for an increase in childhood real per capita consumption expenditures from $1000 to approximately $2700 is estimated to reduce N47 by 2.742.[6]

The results of the fourth regression are quite different from the results of the first three. For the first time, WM31 is significantly positive. WM41 is significantly negative, and the remaining wage variables are insignificant. Two adult unemployment variables (UA31, UA32) have a significantly positive impact on fertility, while only one adult unemployment variable (UA21) has a significantly negative impact on N47; the sum of the UA21, UA22, UA31, UA32, and UA41 coefficients (.007) is incorrectly positive. As Easterlin predicts, an increase in unemployment when children are growing up, *ceteris paribus*, increases completed fertility; UAGS and UAMS are significant and positive.

PREDICTION

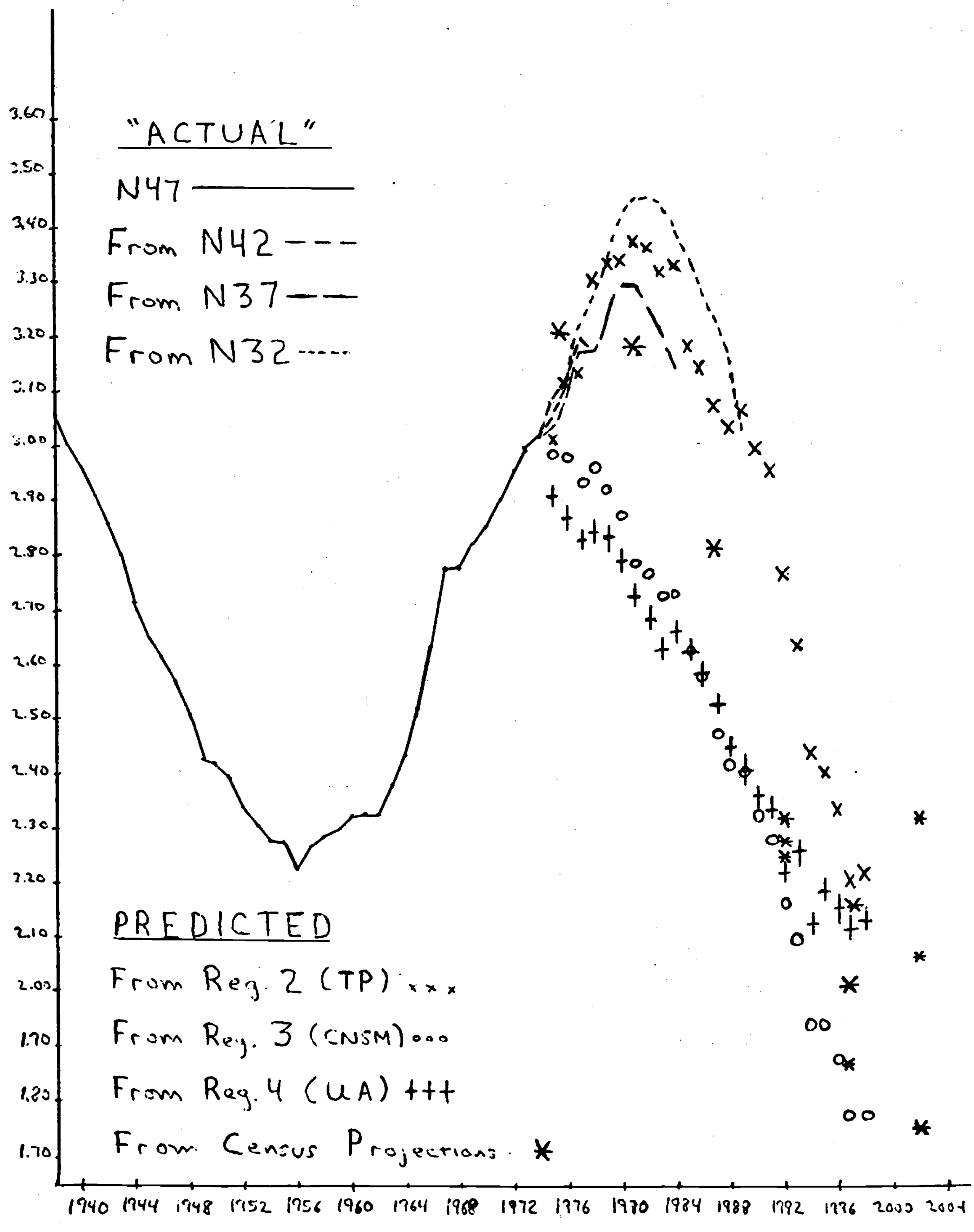
Can a regression which is based on a period in which fertility first fell and then rose correctly predict the level and timing of the peak in completed fertility and furthermore accurately predict how rapidly fertility will subsequently decline? The regressions of Table 1 will now be put to this strong test.

The cumulative birth rates of younger women can be used to "extend" the series on the cumulative birth rate of women aged 47 (N47). In one regression, N47 was estimated as a function of a constant, the year (e.g., 1971), and the cumulative birth rate of women aged 42, lagged 5 years (42). In two other regressions, N42 was replaced with the cumulative birth rate of women aged 37, lagged 10 years (N37) and with the cumulative birth rate of women aged 32, lagged 15 years (N32). In all three regressions, the Cochrane-Orcutt technique has been used to remove serial correlation. The standard errors of the estimate in these regressions were .002, .007, and .018, respectively. Using these regressions, N47 has been predicted for the years 1975-1989. These predictions (called "actual" values henceforth for simplicity) are plotted in Figure 1. N47 is predicted to peak in 1980 or 1981 at 3.29 or 3.46; the former value, generated from more recent fertility data, is a more reliable estimate.

We do not know what the wage rate and the unemployment rate will be in the future. Thus, to use regressions such as those found in Table 1 to predict N47 past 1979, either future values of the wage rate and the unemployment rate must be predicted, or late life cycle wage and unemployment variables (e.g., UA41, WM41) must be deleted from the regressions. Since deleting late life cycle variables increases the incidence of positive auto-correlation, I have chosen to predict the future course of UA and WM. The unemployment rate is assumed to be 7.0 percent in 1977, 6.5 percent in 1978, and the "natural rate" 6.1 percent in 1979 and subsequent years.[7] Predicted values for WM come from a regression in which WM is estimated as a function of a constant, the year, and the growth in the U.S. population lagged 20 years.[8] The population growth variable attempts to capture the depressing effect of a large cohort on wages.

Let us now turn to the predictions of completed fertility. Predicted values of N47 for the years 1975-1998 which have been generated from regressions (2), (3) and (4) in Table 1 are shown in Figure 1. The teachers

FIGURE 1
COMPARISON OF "ACTUAL" AND FITTED VALUES



per child regression (regression (2)) predicts that N47 will peak in 1981 at 3.372 and fall to 2.266 in 1998. This regression forecasts accurately when completed fertility will begin to decline and closely follows the path of "actual" fertility. In contrast, the predictions from "Easterlin" regressions (3) and (4) peak too soon (1975 and 1973, respectively) and are well below "actual" values. In 1998, regressions (3) and (4) predict N47 to be 1.783 and 2.138, respectively.

The statistics found in Table 2 formally compare the "actual" and predicted values of N47. In the years 1975-1984, "actual" values obtained from N37 are compared with predicted values. In the period 1975-1989, "actual" values obtained from N32 are compared with predicted values. Statistics on the partial correlation coefficient between "actual" and predicted values, the root-mean squared error of the prediction, the fraction of error due to bias, the fraction of error due to the regression coefficient of actual on predicted values being different from one, and the fraction of error due to residual variance are presented. When compared to the forecasts from the "Easterlin" regressions, the forecasts from the quantity-quality regressions (regressions (1) and (2)) 1) are more correlated with "actual" values, 2) have smaller errors of prediction, 3) are less biased, and 4) have a smaller fraction of the non-bias error attributable to the regression coefficient being different from unity (i.e., actual values not increasing by one when predicted values increase by one). Thus, the quantity-quality predictions are uniformly preferred to the "Easterlin" predictions.

The ability of the quantity-quality regressions to predict fertility in the 1975-1989 period is not limited by the choice of educational measures. Define DY to be the average number of days attended per academic year in public elementary and secondary schools per child aged 5-17, and define CXT

TABLE 2

ACCURACY OF FORECASTS

	Reg. 1	Reg. 2	Reg. 3	Reg. 4	DY	CXT
Peak						
Year	1979	1981	1975	1973	1979	1978
Predicted Fertility	3.269	3.372	2.988	2.992	3.563	3.265
1975-1984						
Correlation Coefficient	.716	.849	-.562	-.545	.884	.690
Root-mean-squared Error	.083	.098	.364	.440	.208	.062
Error: bias proportion	.061	.522	.811	.884	.802	.073
Error: regression prop.	.479	.287	.155	.092	.166	.027
Error: residual prop.	.460	.190	.034	.024	.033	.899
1975-1989						
Correlation Coefficient	.696	.875	.120	.077	.737	.656
Root-mean-squared Error	.155	.101	.584	.621	.136	.199
Error: bias proportion	.575	.538	.849	.899	.003	.708
Error: regression prop.	.000	.003	.093	.050	.502	.005
Error: residual prop.	.425	.458	.057	.051	.494	.287
Predicted fertility: 1998	-	2.266	1.783	2.138	2.422	2.218

to be the natural logarithm of current educational expenditures on public primary and secondary education per child aged 5-17 divided by the average annual salary of instructional staff. From Table 2, it can be seen that regressions using DYGS, DYMS, and DYHS or CXTGS, CXTMS, and CXTHS have many of the desirable properties of prediction found in regressions (1) and (2).

Finally, let us compare our forecasts with those prepared by the Bureau of the Census (1975). The Bureau of the Census projections, plotted in Figure 1 are based on the birth expectations of young women. For three of the five comparison years, the Bureau of the Census forecasts fall between the quantity-quality forecasts and the Easterlin forecasts, and over the five comparison years, the predictions from the teachers per child regression are on average .2 children greater than the cumulative birth rates forecast by the Bureau of the Census.

EXPLANATION OF BABY BOOM

It is now possible to investigate the cause of the increase in completed fertility associated with the "baby boom." In Table 3, the coefficients of the teachers per child of school age regression have been multiplied by the change in the independent variable values over a specified period to generate a change in the predicted value of N47 over that period attributable to changes in each of the independent variables. For example, 3.015 has been multiplied by the difference between WM21 in 1936 and WM21 in 1926 to yield .427 in the upper left hand corner of Table 3.

Wage effects predict that N47 will fall by .339 per decade between 1926 and 1956, rise by .534 per decade between .956 and 1981, and finally fall by .557 per decade between 1981 and 1998. Approximately 98 percent of the change in the rate of growth of fertility between the decline and

TABLE 3

Changes in N47 (Predicted from Regression 2) as a Result of Changes in Independent Variables

Variables	Decline				Boom				Decline		
	1926-36	1936-46	1946-56	Decade Ave 1926-56	1956-66	1966-76	1976-81	Decade Ave 1956-81	1981-91	1991-98	Decade Ave 1981-98
WM21	.427	.798	.529	.585	1.372	.803	.460	1.054	.611	.310	.542
WM22	.656	.388	.938	.661	.849	.866	.283	.799	.473	.417	.524
WM31	-.031	-.020	-.053	-.035	-.031	-.030	-.011	-.029	-.019	-.027	-.027
WM32	-.568	-1.372	-1.242	-1.061	-1.266	-.790	-.316	-.949	-.972	-.854	-1.074
WM41	-.287	-.744	-.435	-.489	-.424	-.290	-.138	-.341	-.542	-.346	-.522
Summed Wages	.197	-.950	-.263	-.339	.500	.559	.278	.534	-.449	-.500	-.557
UA21	-.022	-.022	-.155	-.066	.200	.011	-.033	.071	.025	-.043	-.011
UA22	-.027	-.004	.138	.036	-.124	.027	.013	-.034	-.014	.015	.001
UA31	.030	.211	-.272	-.010	-.016	.060	-.048	-.002	.066	-.019	.028
UA32	.006	-.210	.189	-.005	-.041	.045	-.044	-.016	-.018	.000	-.011
UA41	-.355	.458	.026	.043	-.101	.026	-.055	-.052	.033	.000	.019
Summed Unempl.	-.368	.433	-.074	-.002	-.082	.169	-.167	-.033	.092	-.047	.026
TPGS	.024	.049	.201	.091	.297	.006	.103	.162	.093	.083	.104
TPMS	-.010	-.324	-.560	-.298	-.349	-.284	-.014	-.259	-.261	-.427	-.405
TPHS	.021	.145	.209	.125	.019	.090	.055	.066	.102	.209	.183
Summed Educ.	.035	-.130	-.150	-.082	-.033	-.188	.144	-.031	-.066	-.135	-.118
Total	-.136	-.647	-.487	-.423	.385	.540	.255	.470	-.423	-.682	-.649

boom and between the boom and subsequent decline is accounted for by changes in wages. Between 1956 and 1981, early life cycle wages (WM21 and WM22) grew unusually rapidly and late life cycle wages (WM32 and WM41) grew unusually slowly. That is, relative to the cohort born in 1909, members of the cohort born in 1934 experienced much higher wages when they were in their twenties and only slightly higher wages when they were in their late thirties and early forties. An increase in early life cycle wages and a decrease in late life wages both increase cumulative birth rates. Thus, this asymmetric growth in wages led to an increase in completed fertility. Correspondingly, slow growth in early life cycle wages and rapid growth in late life cycle wages are predicted to make the post-baby boom decline in fertility more rapid than the pre-baby boom decline in fertility.

The unemployment variables surprisingly mitigate some of the wage effects. Unemployment effects lead to either a small increase or a negligible change in fertility in the years in which completed fertility is declining and lead to a small decrease in completed fertility in the boom years between 1956 and 1981. Changes in UA21 reinforce the effects of wage changes, while changes in UA22 and in UA41 reduce the impact of wage changes.

Approximately 7 percent of the change in the rate of growth of completed fertility is due to fluctuations in the rate of growth of the number of teachers per child of school age. The "baby boom" cohorts were in "middle" school roughly between 1920 and 1945. This was a period in which there was sluggish growth in the number of teachers per child, and that sluggish growth contributed to the increase in family size associated with the baby boom.

CONCLUSION

The life cycle versions of the quantity-quality model and of the Easterlin model both successfully explain the fall and increase in completed fertility between 1923 and 1974. However, the coefficients from the Easterlin regressions are perhaps somewhat less plausible than the coefficients from the quantity-quality regressions. The success or failure of a model in predicting future behavior is a critical test of its worth, and predicting a change in trend is one particularly strong test of a model's merit. The quantity-quality regressions accurately predict the timing and level of the peak in completed fertility and closely follow the path of completed fertility over a fifteen year period that includes the last years of the baby boom and the first few years of the subsequent decline in completed fertility. By any measure, the Easterlin regressions are less successful in predicting fertility in this period; these regressions predict that fertility will peak well before it actually peaks and that fertility will be less than it actually is. The evidence thus supports the hypothesis that the quantity-quality model is a better model of fertility behavior than the Easterlin model.

Much of the increase in completed fertility associated with the baby boom appears to be attributable to the sporadic growth in real wages over time. Therefore, the alternation of protracted periods of rapid wage growth with protracted periods of sluggish wage growth in the future would once again lead to booms and busts in completed fertility. A small part of the baby boom is due to the sluggish growth of schooling inputs. Education is nevertheless an important explanation of time series movements in completed fertility, for the only difference between the accurate predictions of the quantity-quality regressions and the inaccurate predictions of the Easterlin regressions is the choice of the childhood variables which are used in these regressions.

Much more work remains to be done. The time series specification in this paper could be further tested using data from any of a number of other countries that experienced the baby boom. Cross sectional panel studies or retrospective studies provide yet another data source for ascertaining whether the findings of this paper can be replicated.

APPENDIX

Data Sources

WM - U.S. Department of Commerce, Long Term Economic Growth: 1860-1970. I extended the series to cover the years 1964-1976.

UA - Long Term Economic Growth. Darby (1976).

N47 - Vital Statistics of the United States, Vol. I: Notality. P. K. Whelpton and A. A. Campbell, "Fertility Tables for Birth Cohorts of American Women, Part I," Vital Statistics - Special Reports Vol. 51, No. 1, 1960.

E - Current Population Reports, Series P-20. 1940 Census. Information on educational attainment found in the 1940 Census was used to extend this series back over time.

DY - Long Term Economic Growth.

CNSM - Long Term Economic Growth.

TP - National Center for Educational Statistics, A Century of Public School Statistics.

CXT - Long Term Economic Growth. A Century of Public School Statistics.

FOOTNOTES

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1. Infra, pp. 13-14.

2. Note that an increase in the manufacturing wage may be associated more with an increase in the husband's wage than with an increase in the wife's wage.

3. A change in the unemployment rate may also be associated with a change in the value placed upon the wife's time. The "added worker-discouraged worker" controversy in the female labor force participation literature is relevant.

4. An alternative measure of wages, a weighted average of manufacturing and farm wages, did not have a consistent impact on completed fertility and was associated with a greater incidence of autocorrelation than is found in Table 1.

5. Although regressions which did not incorporate Darby's adjustments to the unemployment variables had somewhat greater explanatory power than the regressions in Table 1, the former regressions had a greater incidence of autocorrelation and were less successful in predicting future fertility than the regressions in Table 1.

6. The CNSMGS, CNSMMS, and CNSMHS coefficients have been summed.

7. Barro (1977) estimates that the natural rate of unemployment in 1978 in subsequent years is 6.1 percent.

8. The Cochrane-Orcutt technique has again been used to remove serial correlation.

REFERENCES

Barro, Robert J. "Unanticipated Money Growth and Unemployment in the United States." American Economic Review 67 (March 1977): 101-115.

Becker, Gary S. "An Economic Analysis of Fertility." In Demographic and Economic Change in Developed Countries. Universities - National Bureau Conference Series, No. 11. Princeton, N.J.: Princeton University Press, 1960.

Becker, Gary S. and Lewis, H. Gregg. "On the Interaction between the Quantity and Quality of Children." Journal of Political Economy 81 (March/April 1973): S279-S288.

Bureau of the Census. Current Population Reports, Series P-25, No. 601. "Projections of the Population of the United States: 1975-2050." 1975.

Butz, William P. and Ward, Michael P. "The Emergence of Countercyclical U.S. Fertility." Rand, 1977. (Mimeographed.)

Darby, Michael R. "Three-and-a-half Million U.S. Employees have been Mislaid: Or an Explanation of Unemployment, 1931-1941." Journal of Political Economy 84 (February 1976): 1-16.

DeTray, Dennis N. "Child Quality and the Demand for Children." Journal of Political Economy 81 (March/April 1973): S70-S95.

Easterlin, Richard A. "On the Relation of Economic Factors to Recent and Projected Fertility Changes." Demography 3 (1966): 131-153.

__________. Population, Labor Force, and Long Swings in Economic Growth: The American Experience. New York: Columbia University Press, 1968.

__________. "Towards a Socio-Economic Theory of Fertility: A Survey of Recent Research on Economic Factors in American Fertility." Fertility *and Family Planning: A World View*. Edited by S. J. Behrman, Leslie Corsa, Jr., and Ronald Freedman. Ann Arbor: University of Michigan Press, 1969.

__________. "Relative Economic Status and the American Fertility Swing." *Family Economic Behavior: Problems and Prospects*. Edited by Eleanor Bernert Sheldon. Philadelphia: J. B. Lippincott Co., 1973.

Kenny, Lawrence W. "The Demands for Child Quality and for Educational Inputs, the Production of Child Quality, and Related Topics." Ph.D. dissertation, University of Chicago, 1977.

Kirk, Dudley. "The Influence of Business Cycles on Marriage and Birth Rates." In *Demographic and Economic Change in Developed Countries*. Universities - National Bureau Conference Series, No. 11. Princeton, N.J.: Princeton University Press, 1960.

Lee, Ronald. "Fluctuations in U.S. Fertility, Age Structure and Income." Population Studies Center, University of Michigan, 1977. (Mimeographed.)

Silver, Morris. "Births, Marriages, and Business Cycles in the United States." *Journal of Political Economy* 73 (June 1965): 237-255.

Wachter, Michael L. "A Time-Series Fertility Equation: The Potential for a Baby-Boom in the 1980's." *International Economic Review* 16 (October 1975): 609-624.

Willis, Robert J. "A New Approach to the Economic Theory of Fertility Behavior." *Journal of Political Economy* 81 (March/April 1973):S14-S64.